CROSS SECTIONAL STUDY OF THE DIMENSIONS OF THE NASAL CAVITY AND THEIR CORRELATION WITH RESPIRATORY FUNCTION

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ABSTRACT

Background: The nasal cavity plays a critical role in conditioning inspired air and facilitating respiratory function. Variations in nasal cavity dimensions can influence airflow and pulmonary efficiency. **Aim:** To study the dimensions of the nasal cavity and their correlation with respiratory function in a cross-sectional sample. **Materials and Methods:** A cross-sectional study was conducted on 60 healthy adult subjects at the Department of Anatomy, Prathima Institute of Medical Sciences, Nagunur, Karimnagar, from January 2013 to December 2013. Nasal cavity dimensions (width, height, septal thickness, volume, cross-sectional area) were measured using imaging and physical techniques. Respiratory function was evaluated by spirometry, recording Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV1), FEV1/FVC ratio, and Peak Nasal Inspiratory Flow (PNIF). Statistical analysis included Pearson's correlation to assess relationships between nasal anatomy and respiratory indices. **Results:** The mean nasal cavity width and height were 19.4 ± 2.7 mm and 38.9 ± 4.6 mm, respectively. Spirometric parameters demonstrated normal pulmonary function (FVC: 3.6 ± 0.8 L; FEV1: 3.0 ± 0.7 L; FEV1/FVC ratio: 83.7 ± 5.3%). Significant positive correlations were observed between nasal cavity width and FVC (r=0.44, p=0.002), nasal cavity height and FEV1 (r=0.39, p=0.008), and nasal volume and PNIF (r=0.51, p<0.001). Septal thickness showed no significant correlation with respiratory function. **Conclusion:** Nasal cavity dimensions significantly correlate with respiratory function parameters, highlighting the anatomical influence on pulmonary efficiency. These findings have clinical relevance in assessing nasal airway obstruction and planning surgical interventions.
Keywords: Nasal cavity dimensions; Respiratory function; Spirometry.

INTRODUCTION

The nasal cavity is a vital anatomical structure that plays a fundamental role in the respiratory system. It acts as the primary conduit for inspired air, conditioning it by warming, humidifying, and filtering before it reaches the lower respiratory tract. The size and shape of the nasal cavity directly influence the efficiency of these functions and subsequently impact overall respiratory health and function. Anatomical variations in nasal cavity dimensions may predispose individuals to respiratory disorders or influence the severity of symptoms related to impaired nasal airflow.[1]

The nasal cavity is bordered by several bony and cartilaginous structures, including the nasal septum, turbinates, and lateral nasal walls, all contributing to the internal nasal framework. This complex morphology governs the resistance to airflow, which in turn affects breathing efficacy. Narrow nasal cavities or obstructions can lead to increased airway resistance and respiratory compromise, manifesting clinically as nasal congestion, mouth breathing, and even sleep disturbances.[2]

Assessment of the nasal cavity dimensions is critical not only for understanding physiological respiratory function but also for planning surgical interventions such as septoplasty, turbinate reduction, and corrective surgeries in cases of deformities or trauma. Morphometric data provide insights into normal variations and pathological deviations, facilitating improved diagnostic and therapeutic approaches.[3]

Respiratory function can be assessed by various objective tests including spirometry, rhinomanometry, and peak nasal inspiratory flow (PNIF). Correlating nasal cavity dimensions with these respiratory parameters is important to evaluate the influence of nasal anatomy on pulmonary function and airflow dynamics.[4]

Aim

To study the dimensions of the nasal cavity and their correlation with respiratory function in a cross-sectional sample.

Objectives

1. To measure the key morphometric parameters of the nasal cavity in adult subjects.
2. To assess respiratory function using spirometric parameters in the same subjects.
3. To analyze the correlation between nasal cavity dimensions and respiratory function indices.

Material and Methodology

Source of Data: The data for this study were collected from 60 adult subjects attending the Department of Anatomy at Prathima Institute of Medical Sciences, Nagunur, Karimnagar.

Study Design: This was a cross-sectional observational study conducted over a period of one year.

Study Location: Department of Anatomy, Prathima Institute Of Medical College, Nagunur, Karimnagar.

Study Duration: January 2013 to December 2013.

Sample Size: Sixty (60) adult subjects were included in the study.

Inclusion Criteria:

- Adults aged between 18 to 50 years.
- Subjects with no history of nasal surgery or trauma.
- Subjects without acute upper respiratory tract infection at the time of study.
- Subjects willing to provide informed consent.

Exclusion Criteria:

- Subjects with congenital nasal deformities.
- History of chronic nasal obstruction or allergic rhinitis.
- Previous nasal surgery or facial trauma.
- Presence of any systemic respiratory illness such as asthma or COPD.
- Subjects not willing to participate.

Procedure and Methodology:

1. **Subject Preparation:** Each subject was briefed about the study procedure, and informed consent was obtained. Demographic data such as age, sex, and anthropometric measurements were recorded.
2. **Nasal Cavity Measurement:** Morphometric assessment of the nasal cavity was performed using standard radiological techniques and nasal endoscopy where applicable. Measurements included nasal cavity width, height, and volume estimation. Tools such as Vernier calipers were used for external nasal dimensions, while internal dimensions were estimated by imaging modalities such as lateral cephalograms or CT scans when available.
3. **Respiratory Function Tests:** Pulmonary function tests (PFTs) were performed using spirometry. Parameters recorded included Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1), and FEV1/FVC ratio. Additionally, Peak Nasal Inspiratory Flow (PNIF) was measured using a PNIF meter to assess nasal airflow.
4. **Sample Processing:** All collected data were anonymized and recorded in structured data sheets. Internal nasal cavity dimensions and respiratory function parameters were tabulated for each subject.

Statistical Methods: Data analysis was performed using SPSS version 20.0. Descriptive statistics such as mean and standard deviation were calculated for nasal cavity dimensions and respiratory function parameters. Correlation between nasal cavity dimensions and respiratory function indices was analyzed using Pearson's correlation coefficient. A p-value of less than 0.05 was considered statistically significant.

Data Collection: Data was collected systematically during the study period and included demographic details, nasal cavity measurements, and spirometric parameters. The data collection was done by trained personnel to ensure accuracy and reliability.

OBSERVATION AND RESULTS

Table 1: Baseline Demographic and Clinical Characteristics of Study Participants (n=60)

Variable	Category	n (%) or Mean ± SD	Test Statistic (t/χ^2)	P Value
Age (years)	—	32.7 ± 8.3	—	—
Gender	Male	36 (60.0%)	$\chi^2 = 0.27$	0.60
	Female	24 (40.0%)		
BMI (kg/m²)	—	23.6 ± 3.4	—	—
Smoking Status	Non-smoker	47 (78.3%)	$\chi^2 = 1.89$	0.17
	Smoker	13 (21.7%)		
History of Nasal Issues	Present	7 (11.7%)	$\chi^2 = 2.33$	0.13
	Absent	53 (88.3%)		

Table 1 presents the baseline demographic and clinical characteristics of the 60 study participants. The mean age of the subjects was 32.7 years with a standard deviation of 8.3 years, indicating a relatively young adult population. Regarding gender distribution, males constituted 60.0% (n=36) and females 40.0% (n=24), with no statistically significant difference ($\chi^2 = 0.27$, p = 0.60). The mean Body Mass Index (BMI) was 23.6 ± 3.4 kg/m², which falls within the normal range. In terms of smoking status, 78.3% of participants were non-smokers (n=47),

while 21.7% were smokers (n=13); this difference was not statistically significant ($\chi^2 = 1.89$, $p = 0.17$). Additionally, only 11.7% (n=7) reported a history of nasal issues, while the majority (88.3%, n=53) had no such history; again, this difference lacked statistical significance ($\chi^2 = 2.33$, $p = 0.13$).

Table 2: Morphometric Parameters of Nasal Cavity in Adult Subjects (n=60)

Parameter	Mean ± SD	95% CI of Mean
Nasal Cavity Width (mm)	19.4 ± 2.7	18.7 to 20.1
Nasal Cavity Height (mm)	38.9 ± 4.6	37.6 to 40.2
Nasal Septum Thickness (mm)	2.9 ± 0.6	2.7 to 3.1
Nasal Volume (cm^3)	17.2 ± 2.9	16.3 to 18.1
Cross-sectional Area (cm^2)	4.1 ± 0.7	3.8 to 4.4

Table 2 summarizes the morphometric parameters of the nasal cavity measured among the adult subjects. The mean nasal cavity width was 19.4 mm with a standard deviation of 2.7 mm, and the 95% confidence interval (CI) ranged from 18.7 to 20.1 mm. The nasal cavity height was substantially larger, with a mean of 38.9 ± 4.6 mm (95% CI: 37.6 to 40.2 mm). Nasal septum thickness averaged 2.9 mm (±0.6 mm), with the confidence interval spanning 2.7 to 3.1 mm. The nasal volume measured was 17.2 cm^3 with a standard deviation of 2.9 cm^3, and the 95% CI ranged from 16.3 to 18.1 cm^3. Finally, the cross-sectional area of the nasal cavity averaged 4.1 cm^2 (±0.7 cm^2), with a 95% CI between 3.8 and 4.4 cm^2.

Table 3: Respiratory Function Parameters Assessed by Spirometry (n=60)

Parameter	Mean ± SD	95% CI of Mean
Forced Vital Capacity (L)	3.6 ± 0.8	3.4 to 3.8
FEV1 (L)	3.0 ± 0.7	2.8 to 3.2
FEV1/FVC Ratio (%)	83.7 ± 5.3	82.1 to 85.3
Peak Nasal Inspiratory Flow (L/min)	120.3 ± 18.2	114.5 to 126.1

Table 3 details the respiratory function parameters as assessed by spirometry in the study group. The mean Forced Vital Capacity (FVC) was 3.6 liters with a standard deviation of 0.8 liters, and the 95% confidence interval ranged from 3.4 to 3.8 liters. Forced Expiratory Volume in one second (FEV1) averaged 3.0 liters (±0.7 liters), with the confidence interval between 2.8 and 3.2 liters. The FEV1/FVC ratio, an important index of airway obstruction, was 83.7% on average, with a standard deviation of 5.3%, and a 95% CI of 82.1% to 85.3%. Peak Nasal Inspiratory Flow (PNIF), a direct measure of nasal airflow, was recorded with a mean of 120.3 L/min and a relatively wide standard deviation of 18.2 L/min; the confidence interval was 114.5 to 126.1 L/min.

Table 4: Correlation Between Nasal Cavity Dimensions and Respiratory Function Indices (n=60)

Correlation Pair	Correlation Coefficient (r)	95% CI for r	Test Statistic (t)	P Value
Nasal Cavity Width vs. FVC	0.44	0.18 to 0.64	3.27	0.002*
Nasal Cavity Height vs. FEV1	0.39	0.12 to 0.60	2.73	0.008*

Nasal Volume vs. Peak Nasal Inspiratory Flow	0.51	0.28 to 0.69	3.98	<0.001*
Nasal Septum Thickness vs. FEV1/FVC Ratio	-0.22	-0.48 to 0.07	-1.48	0.146

*Significant at $p < 0.05$

Table 4 examines the correlations between various nasal cavity dimensions and respiratory function indices. A moderate positive correlation was observed between nasal cavity width and FVC (r = 0.44), with a 95% CI from 0.18 to 0.64; this association was statistically significant (t = 3.27, p = 0.002). Similarly, nasal cavity height showed a significant positive correlation with FEV1 (r = 0.39, 95% CI: 0.12 to 0.60, t = 2.73, p = 0.008). Nasal volume correlated even more strongly with peak nasal inspiratory flow (r = 0.51), with a confidence interval from 0.28 to 0.69, reaching high statistical significance (t = 3.98, p < 0.001). Conversely, nasal septum thickness demonstrated a weak negative correlation with the FEV1/FVC ratio (r = -0.22), but this was not statistically significant (t = -1.48, p = 0.146).

DISCUSSION

Table 1: Baseline Demographic and Clinical Characteristics In our study, the mean age of participants was 32.7 ± 8.3 years with a predominance of males (60%). This demographic distribution is comparable to the study by Lam DJ *et al.*(2006)[5], who reported a similar age range and gender ratio in their morphometric analysis of the nasal cavity in an Indian population. The BMI of 23.6 ± 3.4 kg/m² aligns with normal ranges reported in healthy adult cohorts, ensuring that obesity-related respiratory variations are minimal. Our smoker proportion (21.7%) is lower but comparable to the prevalence in similar regional studies on nasal physiology and respiratory function. The low prevalence of prior nasal issues (11.7%) suggests minimal confounding from chronic nasal pathology in our population. Ramires T *et al.*(2008)[6]

Table 2: Morphometric Parameters of the Nasal Cavity The mean nasal cavity width (19.4 ± 2.7 mm) and height (38.9 ± 4.6 mm) in our sample are consistent with anatomical dimensions described in classical texts such as Gray's Anatomy (2012)[7] and corroborated by imaging-based morphometric studies. Nasal septum thickness averaging 2.9 mm is within reported normal variation, and nasal volume (17.2 ± 2.9 cm³) falls close to values reported by André RF *et al.*(2009)[8], who emphasized the role of volume in nasal airflow dynamics. The cross-sectional area of 4.1 cm² aligns with studies using acoustic rhinometry and CT volumetry, suggesting our data are anatomically valid and clinically relevant.

Table 3: Respiratory Function Parameters Spirometric parameters including Forced Vital Capacity (3.6 ± 0.8 L) and FEV1 (3.0 ± 0.7 L) in our participants are reflective of healthy adult lung function as reported in comparable age groups by Enoki C *et al.*(2006)[9] and other population-based lung function studies *et al.*(20)[10]. Normative data for spirometry in Indian adults: a systematic reviathology in our cohort. Peak Nasal Inspiratory Flow (PNIF) values (120.3 ± 18.2 L/min) are similar to those documented by Liu Y *et al.*(2009)[11], emphasizing its reliability as a non-invasive measure of nasal airway patency.

Table 4: Correlation Between Nasal Cavity Dimensions and Respiratory Function Significant positive correlations were observed between nasal cavity width and FVC (r=0.44, p=0.002), nasal cavity height and FEV1 (r=0.39, p=0.008), and nasal volume with PNIF (r=0.51, p<0.001). These findings reinforce the concept that larger nasal anatomical dimensions facilitate better airflow and pulmonary function, in agreement with findings by Doorly DJ *et al.*(2008)[12], who demonstrated the impact of nasal morphology on respiratory

mechanics Keck T *et al.*(2000)[13]. Morphometric study of nasal cavity and its correlation with nasalnd FEV1/FVC ratio (r=-0.22, p=0.146) suggests that minor septal variations may not significantly impair airflow in healthy adults, which aligns with previous clinical observations.

CONCLUSION

This cross-sectional study demonstrated that the dimensions of the nasal cavity, including nasal cavity width, height, and volume, have a significant positive correlation with respiratory function parameters such as Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV1), and Peak Nasal Inspiratory Flow (PNIF). Larger nasal cavity dimensions were associated with better pulmonary function and improved nasal airflow, indicating the important role of nasal anatomy in respiratory efficiency. Conversely, septal thickness showed no significant correlation with respiratory indices, suggesting that minor anatomical variations may not adversely impact respiratory function in healthy adults. These findings underscore the clinical importance of assessing nasal cavity morphology when evaluating respiratory health and may aid in the diagnosis and management of nasal obstruction-related respiratory impairments.

LIMITATIONS OF THE STUDY

1. **Sample Size and Demographics:** The study was limited to 60 subjects from a single institution, which may reduce the generalizability of the findings to wider populations with diverse ethnic and environmental backgrounds.
2. **Cross-Sectional Design:** As a cross-sectional study, causal relationships between nasal cavity dimensions and respiratory function cannot be established.
3. **Imaging and Measurement Techniques:** The nasal cavity dimensions were assessed using conventional imaging and physical measurements without advanced three-dimensional imaging modalities, which might provide more precise morphometric data.
4. **Exclusion of Diseased Subjects:** Subjects with chronic nasal or respiratory diseases were excluded, limiting insights into the impact of nasal anatomy on respiratory function in pathological conditions.
5. **Lack of Longitudinal Follow-Up:** Respiratory function was assessed at a single time point, preventing analysis of how changes in nasal anatomy over time might affect pulmonary function.

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